Women and Software Engineering

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ABSTRACT

My goal with this text is to provide some concepts and questions that can help the reader to reflect on and elevate the discussion about Women and Software Engineering by providing historical data and some reflection points for the future. Feminism constitutes both a theoretical perspective and a social movement aiming to diminish and ultimately eliminate gender-based inequality and oppression. Data feminism merges data science with feminist principles to examine and address biases and power dynamics in data and technology. Studies at the intersection between gender and software engineering cover gender representation, barriers, and experiences. The main questions I propose for future reflections in the community are: What are the benefits that women bring to software engineering? How does the career and the life of female software engineers unfold? How should software engineering research change so that feminist principles are incorporated? How can feminist knowledge and processes help to examine power structure in software engineering?

1. INTRODUCTION

The Software Engineering concept was coined by a woman, Margaret Hamilton. Margaret Elaine Hamilton (born 1936) is an American computer scientist, systems engineer, and business owner. She was director of the Division of the MIT Instrumentation Laboratory, which developed onboard flight software for NASA's Apollo program. She later founded two software companies. She invented the term "software engineering" in the late '60s, stating: "I began to use the term 'software engineering' to distinguish it from hardware and other kinds of engineering, yet treat each type of engineering as part of the overall systems engineering process."[4]. In spite of notable women in software engineering, paradoxically more than 50 years later, merely 5.17% of the worldwide software developer population (27 million) is comprised of women [25]. Moreover, the idea of a software engineer is a male stereotype. I asked OpenArt to draw four software engineers and it made five (yes, five! this is not my mistake, but the mistake of OpenArt) white men (see figure 1].

In this paper, I will connect women to software engineering by first introducing the concept of feminism and data feminism. Then I will introduce software engineering studies about gender. Finally, I will give some ideas for reflections.

2. ABOUT WOMEN

The most common way to reflect about women is through feminism. Feminism constitutes both a theoretical perspective and a social movement aiming to diminish and ultimately eliminate sexist inequality and oppression [2].

The waves of feminism represent different periods and focuses in the feminist movement: The first wave (late 19th to early 20th
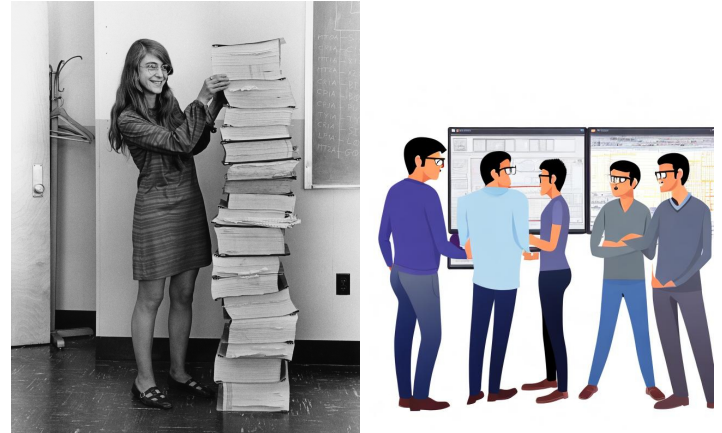
(a) Margaret Hamilton, pict. available on Public Domain

(b) OpenArt Discovery rendering https://openart.ai/discovery.

Figure 1: Women and Software Engineering: a paradox.

century) primarily focused on legal issues, particularly women's right to vote. The Second Wave (1960s to 1980s) addresses workplace discrimination, reproductive rights, and societal expectations of women. The achievements of the Second Wave include the availability of contraception and the emergence of feminist literature and theory. The third wave (1990s to early 2000s) includes intersectionality, recognizing and addressing the unique challenges faced by women of different races, ethnicities, sexual orientations, etc. The Fourth Wave (emerging in the 2010s) utilizes social media and online platforms for activism (e.g.#MeToo movement). It addresses issues like sexual harassment, assault, reproductive justice, and continues to emphasize intersectionality. In 2023 Claudia Godin got the Nobel Prize in Economics for her studies about labour markets and the gender pay gap. While feminist studies about technology have been going on for a long time, the intersection between feminism and software engineering is not explored. Waves exclude multicultural feminism and global feminist movement. The concept of intersectionality, introduced by Crenshaw [6], explores the interconnectedness of social differences, including race, gender, class, ethnicity, sexuality, and nationality, among others. It draws attention to the systemic power dynamics emerging from the interaction of various dimensions of social difference across individual, institutional, cultural, and societal spheres of influence.

Data feminism, a concept by D'Ignazio and Klein presented in their book "Data Feminism" [8], merges data science with feminist principles to examine and address biases and power dynamics in data and technology. Data feminism emphasizes the impor-

tance of recognizing and challenging gender-based inequalities in data collection, analysis, and interpretation. It seeks to promote inclusivity, ethical data practices, and social justice within the realms of technology and data-driven decision-making. Intersectional approaches recognize that people's experiences are shaped by multiple factors, not solely by gender [15].

Neither the intersectionality work nor data feminism explicitly refer to software engineering.

3. ABOUT SOFTWARE ENGINEERING

There are three main stakeholders in software engineering: users, practitioners, and researchers. In 2023, global internet users reached 5.3 billion, constituting 65.7% of the world population [25]. About 70% of males and 63% of females globally use the internet [25], but the evident gender parity among internet users does not continue into the software engineering profession. In Europe, only 20% of ICT specialists (practitioners) are female [10], and merely 5.17% of the worldwide software developer population (27 million) is comprised of women [25].

Studies reveal a concerning trend: women leave the IT profession at a higher rate than men, with 50% resigning from tech roles before the age of 35 [14]. Additionally, women's representation as authors in software engineering papers is only 16.24% [28]. In the context of gender equality in the EU, a 2023 report indicates that women hold just 19% of Full Professor positions in STEM fields [9]. Researchers explore gender impact on **Software Processes**, including collaboration, communication, and leadership in software development teams [18] [23]. Studies investigate how gender dynamics influence development processes, team interactions, and decision-making [21]. They also examine organizational cultures affecting women's retention and advancement in software engineering [26]. Gender-diverse teams show fewer "community smells" and higher productivity [5] [27]. Gender-Inclusive Software combines software engineering and Feminist HCI, aiming to design software for diverse gender needs [1]. Margarett Burnett with GenderMag focuses on crafting inclusive interfaces and systems [3]. Studies highlight a link between gender diversity and increased politeness, emphasizing the importance of gender-inclusivity in software design [19]. In **open-source software**, studies cover gender representation, barriers, and experiences [24]. OSS data sets explore the relation between gender balance and software process quality [5] [19]. Researchers address gender disparities in computing education[11]. My work includes interventions for children, teens, and university students [20] [12] [13] [18] to increase interests of young women for computer science and software engineering.

Several studies address societal and ethical perspective by examining technology's broader gender implications, including bias in stakeholders and algorithms [29] [16] [22] [7] [30]. The questions and the studies here presented examine the power structures in software engineering, but they fail to refer to "power" as a concept.

The questions that are addressed by the EUGAIN[17] project can be reused by those who want to set up interventions to mitigate the gender gap.

1. How to have more girls choose CS as their higher education studies and profession;

2. How to retain female students and ensure they finish their studies and start successful careers in the field;

3. How to encourage more female Ph.D. and postdoctoral researchers to remain in their academic career and apply for professorships in CS departments;

4. How to support and inspire young women in their careers and help them to overcome the main hurdles that prevent women from reaching senior positions in the industry and public sector.

5. Which communication and dissemination strategy to adopt in this field.

At the time of writing, work is still ongoing for answering questions 4, and 5. EUGAIN provides, available at its website a set of booklets and scientific papers that provide answers to questions 1,2,3 research. Results indicate that the following components should be explored:

- To recruit from schools to universities and to PhD: Digital gaming and creative arts activities designed for girls; Provide non-stereotypical role models; Portray work in computing as helpful, altruistic, and community-oriented; Educate teachers providing them with tools and approaches to better engage girls.

- To encourage more women to remain in academia: Inclusive language when advertising positions, stating that you are an equal opportunity employer; approach candidates directly and indirectly; Use quotas or dedicated positions.

4. CONCLUSIONS AND FURTHER WORK

I propose the following questions to reflect on Women and Software Engineering:

- What are the benefits that women bring to software engineering (process and/or product)?

- How does the career and the life of female software engineers unfold?

- How should software engineering research change so that feminist principles are incorporated?

- How can feminist knowledge and processes help to examine power structure in software, software engineering, and software engineering research?

The community must address these questions now that AI systems are being developed and pose a risk that old stereotypes are perpetuated and reinforced.

Acknowledge

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